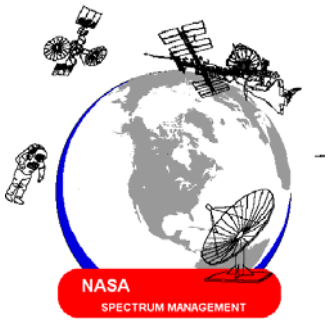

In-Orbit EESS X-Band Systems

Congestion Animation & Analysis

EESS Wideband Downlink Workshop
March 25-27, 2003

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ASRC Aerospace Corporation

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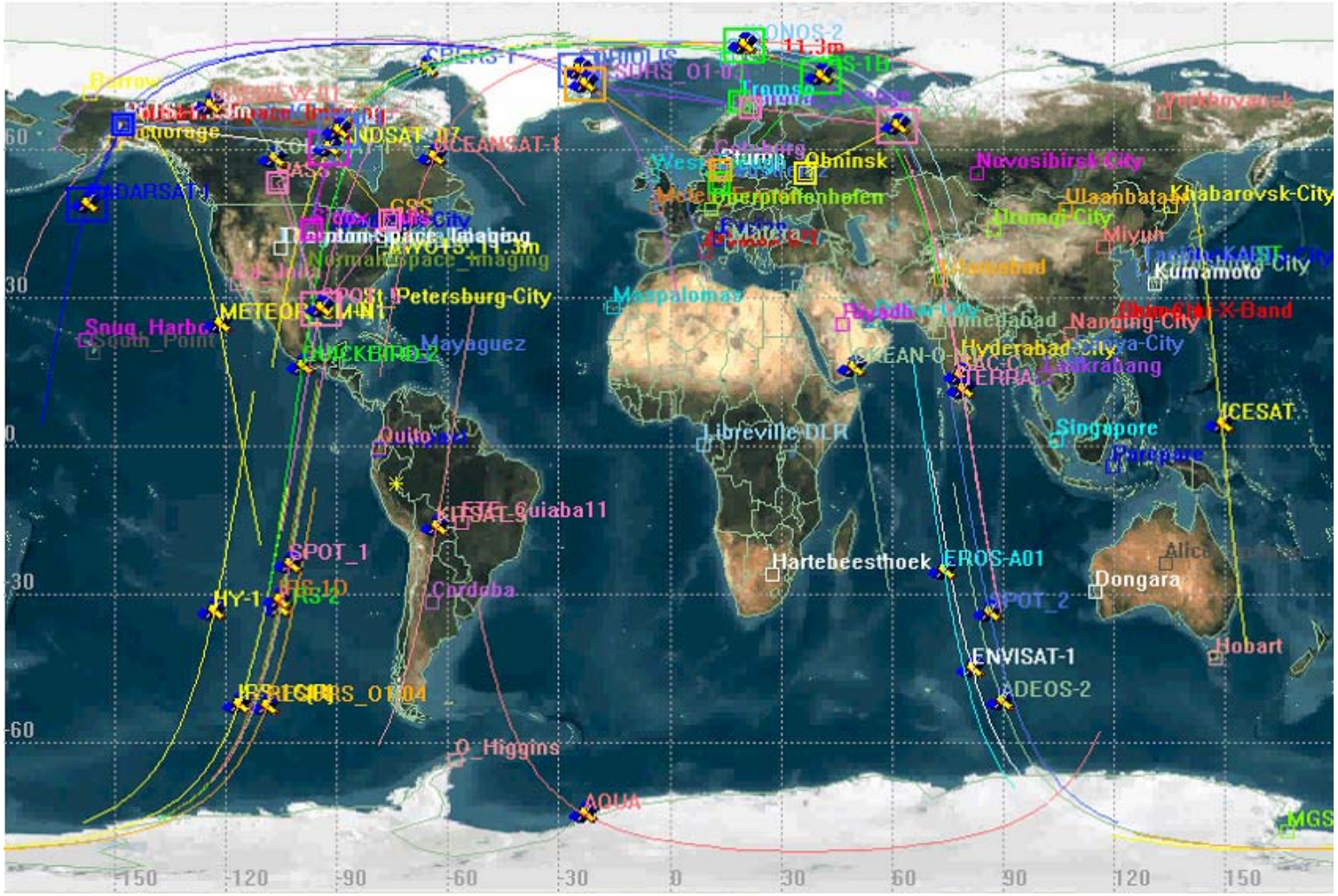
Background & Objective

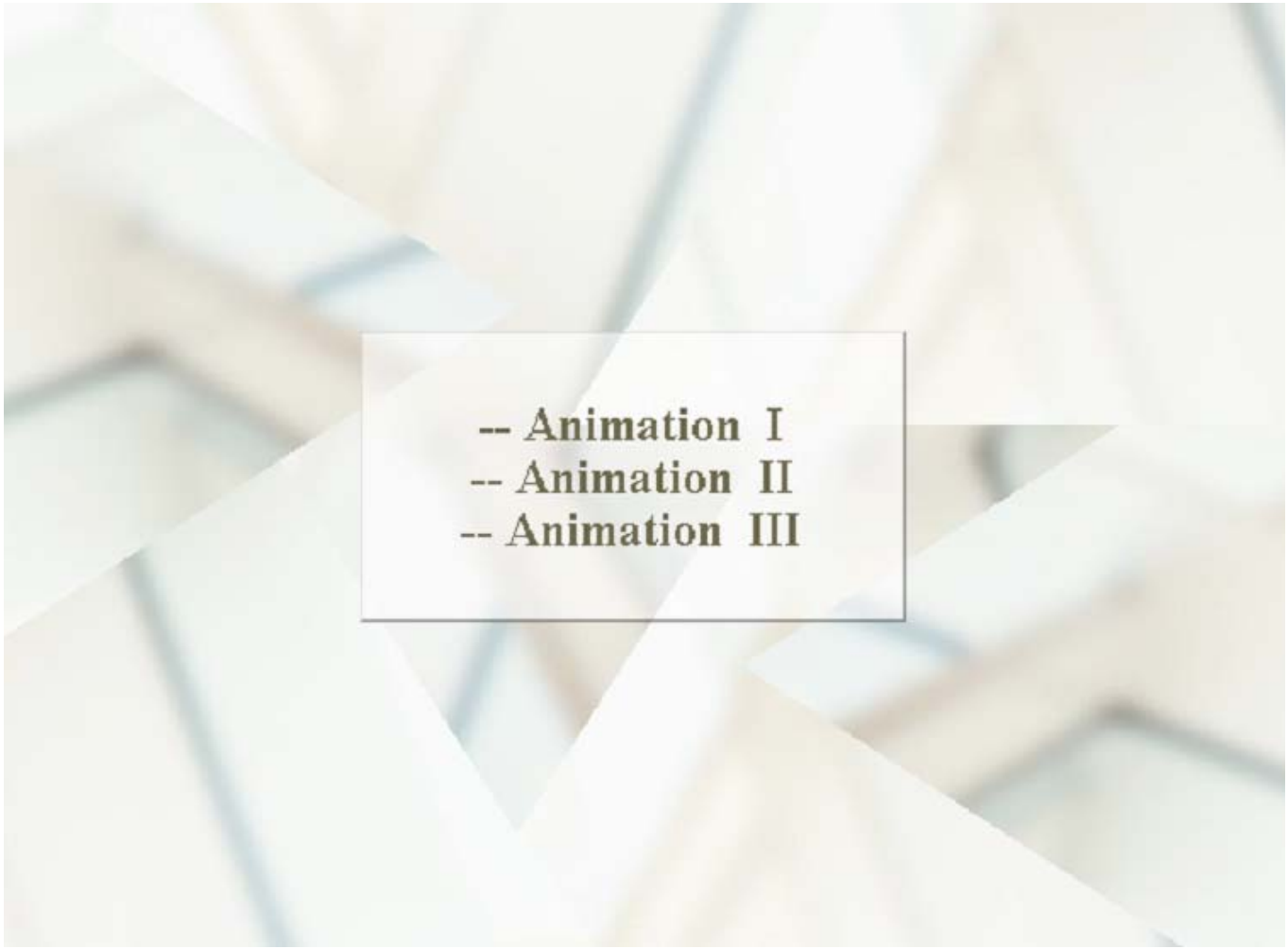
- Part of Effort to "*Characterize EESS Use of the 8025-8400 MHz Band*"
  - Prior Studies Have Not Provided Sufficient Insight Into Congestion Issues
    - Typically Focused on Single Dimension [*either* Time, Space, *or* Frequency]
      - E.g., 8025-8400 MHz EESS Frequency Utilization Charts
    - Statistics [*e.g., %time outage*] Often Used in RFI Simulation Mask Other Issues
      - Impact of "Orbital Clustering" on Congestion
- Present Effort Uses COTS Orbital Simulation Tool
    - Enables Precision and Realism in Orbital Modeling
      - March 2003 TWE [2-Line Elements]
      - Automatically Accounts for Intentional and "Unintentional" Constellations
    - Study Limited to In-Orbit Satellites
      - Planned Satellites Do Not Have Precise Orbital Characteristics Defined
    - Built-In Mechanisms for Assessing Interference
      - Present Effort Limited to Cone-Angle Analysis
    - Enables Generation of Orbital Video for Presentation
      - Insight into Relationship Among Various Spacecraft and Earth Stations

PART 1: Orbital Animation

What to Look For in Orbital Animation



Animation Video File Menu



Orbital Animation

See External Video File

(approx 600 Mbytes)

PART 2: Numerical Assessments

Contention Within Supported Manifest

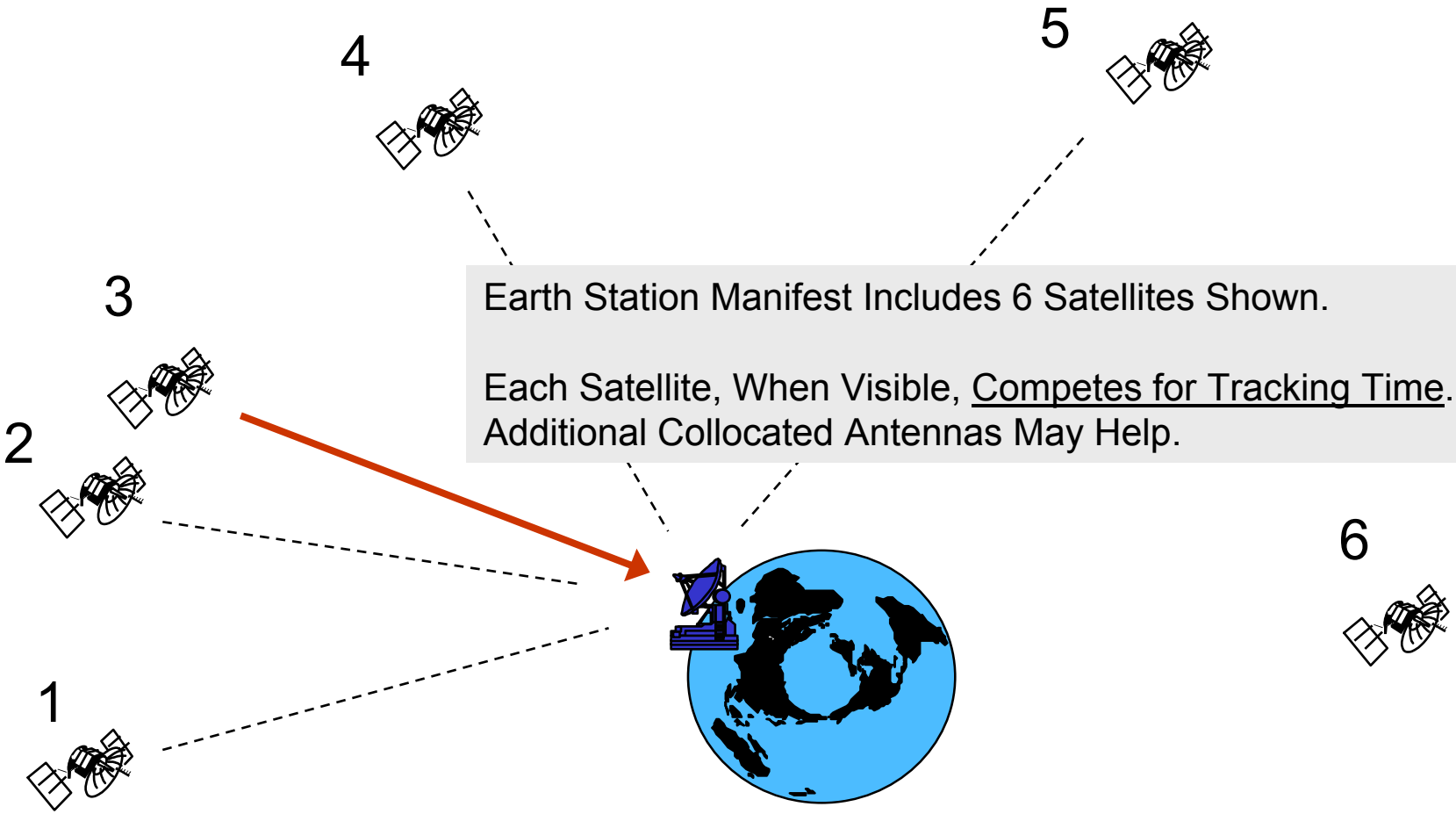
Self-Interference Within Supported Manifest

External Interference into Supported Manifest

Earth Station Support Manifests

Earth Station ***(location)***	**In-Orbit Spacecraft Support Manifest @ 8025-8400 MHz**
Cordoba *(Argentina, Cordoba, Falda Del Carmen)*	AQUA, EROS-A1, ERS-2, Landsat-7, SAC-C
Hiroshima *(Japan, Hiroshima)*	AQUA, EROS-A1, Landsat-7, SPOT-1, SPOT-2, SPOT-4, SPOT-5, Terra
Kiruna_Esrange *(Sweden, Kiruna)*	Adeos-II, Coriolis, IKONOS-2, Landsat-7, Resurs-01-03, Resurs-01-04, SPOT-1, SPOT-2, SPOT-4, SPOT-5
PASS *(Canada, Saskatchewan, Prince Albert)*	Envisat-1, EROS-A1, ERS-2, Landsat-7, Radarsat-1, SPOT-1, SPOT-2, SPOT-4, SPOT-5
SGS_11.3m *(Norway, Svalbard [Spitzbergen])*	AQUA, EO-1, Icesat, Landsat-7, Terra
Note: Based on EESS Wideband Downlink Workshop: "Database of EESS Space and Ground Assets in 8025-8400 MHz"	

Contention Analysis

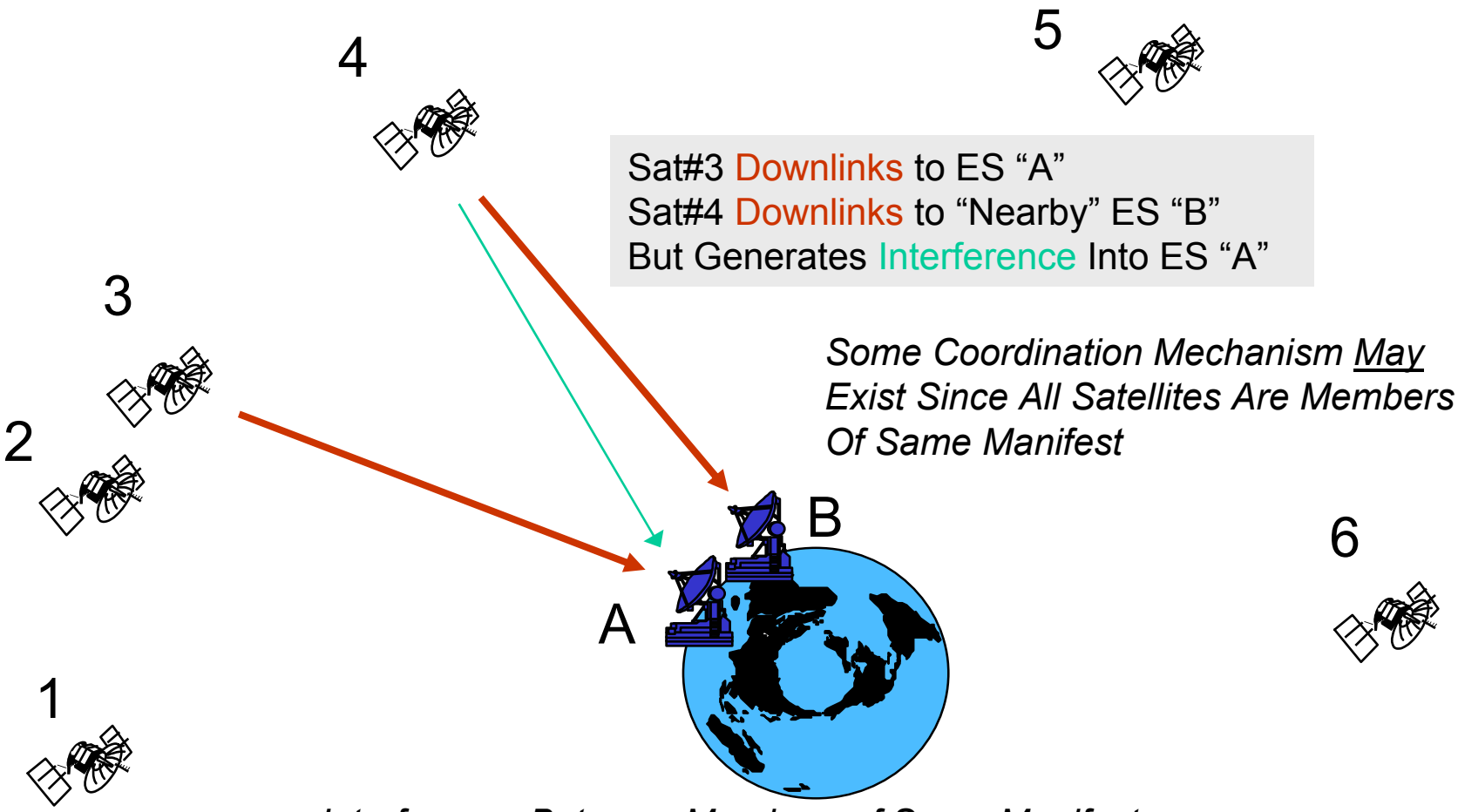


Earth Station Manifest Includes 6 Satellites Shown.

Each Satellite, When Visible, Competes for Tracking Time.
Additional Collocated Antennas May Help.

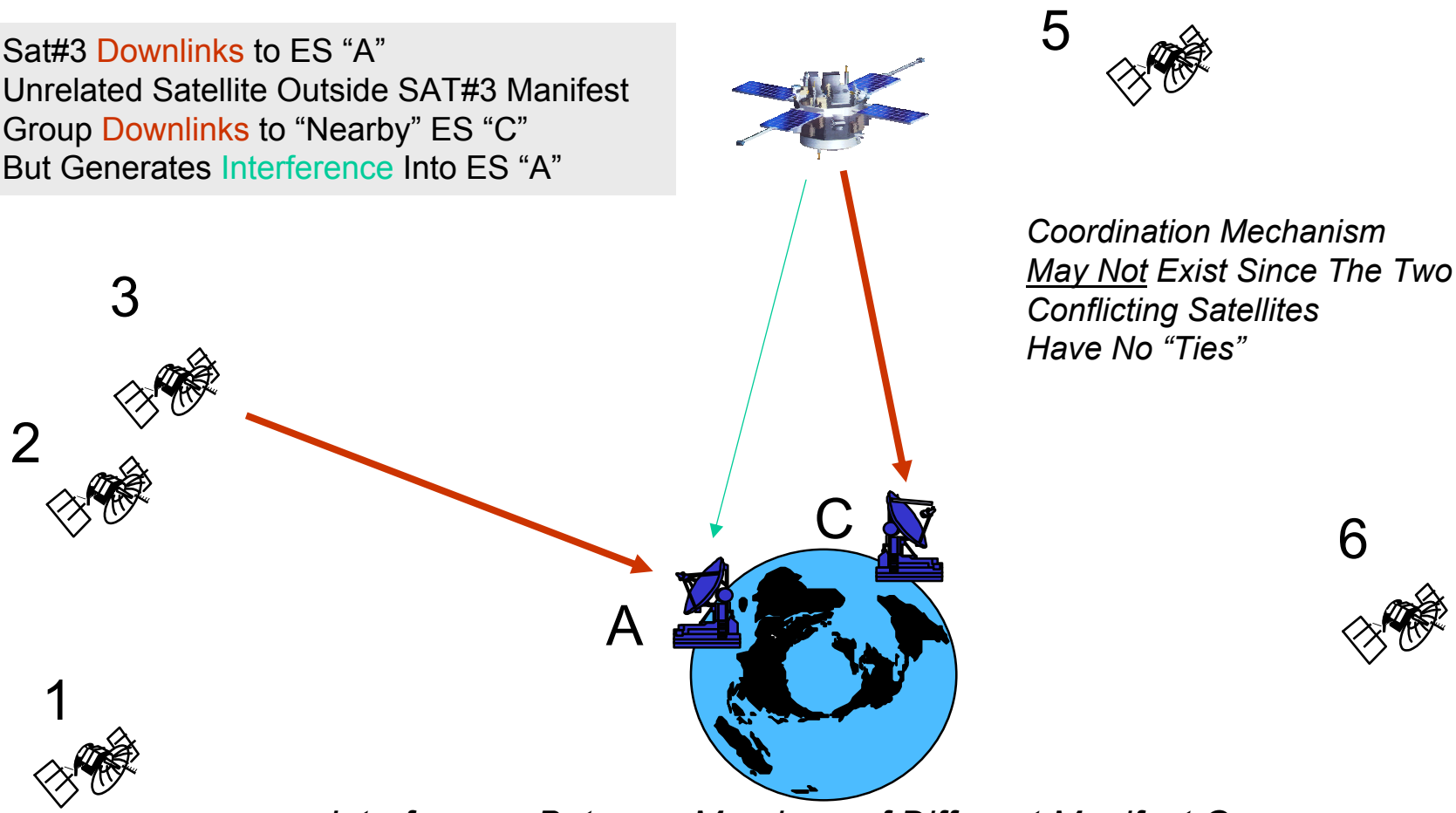
Resource Competition Among Members of Same Manifest

Self-Interference Analysis



External Interference Analysis

Sat#3 Downlinks to ES “A”
Unrelated Satellite Outside SAT#3 Manifest Group Downlinks to “Nearby” ES “C”
But Generates Interference Into ES “A”



Coordination Mechanism
<u>May Not</u> Exist Since The Two
Conflicting Satellites
Have No “Ties”

Interference Between Members of Different Manifest Groups

Summary of Results

Estimated Percentage Reduction in Tracking Time*

Earth Station Manifest	Percent Tracking Time Reduction due to **Contention**	Percent Reduction due to **Self-Interference** [5 degree off-axis]	Percent Reduction due to **External Interference**	
			2.5 degree off axis	1.5 degree off axis
Cordoba	Min: 2.6% Max: 26.9%	Min: 0 Max: 0	Min: 0 Max: 8.1%	Min: 0 Max: 1.6%
Hiroshima	Min: 19.3% Max: 61.1%	Min: 0 Max: 1.9%	Min: 0 Max: 10.4%	Min: 0 Max: 1.2%
Kiruna_Esrange	Min: 16.0% Max: 81.9%	Min: 0.2% Max: 5.8%	Min: 0 Max: 3.1%	Min: 0 Max: 1.5%
PASS	Min: 23.2% Max: 74.2%	Min: 0.4% Max: 5.1%	Min: 0 Max: 14.8%	Min: 0 Max: 8.6%
SGS_11.3m	Min: 7.4% Max: 93.6%	Min: 0 Max: 8.8%	Min: 0.1% Max: 1.4%	Min: 0.0% Max: 0.6%

**Notes: Frequency offset not taken into account in assessing interference; (2) Min/Max variation is over spacecraft within given Mission Manifest; (3) Estimates use RSS averaging whenever multiple interference sources exist.*

Detailed Assessments of Contention, Self-Interference and External Interference

Cordoba

Hiroshima

Kiruna_Esrange

PASS

SGS_11.3m

Note: Frequency offset not taken into account in assessing interference

Cordoba Manifest Analysis

Contention and Self-Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due To Contention *(minutes)*	Time Reduction Due To Self-Interference [5 degree off-axis] *(minutes)*
AQUA	116.6	3.0	0.0
EROS-A1	70.3	15.8	0.0
ERS-2	134.1	32.6	0.0
Landsat-7	114.9	20.3	0.0
SAC-C	115.2	31.0	0.0

Note: Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total

Cordoba Manifest Analysis

External Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due to External Interference			
		5.0 degree off-axis		1.5 degree off-axis	
		Time *(minutes)*	Interference Source(s)	Time *(minutes)*	Interference Source(s)
AQUA	116.6	0.0	--	0.0	--
EROS-A1	70.3	1.9	(1)	0.5	(5)
ERS-2	134.1	10.2 2.6 2.6	(2) (3) (4)	2.2	(6)

Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total

Interference sources are: (1) CBERS-1 to ETE_Cuiaba-11; (2) IRS-1D to Cotopaxi; (3) SPOT-1 to Cotopaxi; (4) SPOT-1 to ETE-Cuiaba-11; (5) CBERS-1 to ETE_Cuiaba-11; (6) IRS-1D to Cotopaxi

[continued]

Cordoba Manifest Analysis

External Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due to External Interference			
		5.0 degree off-axis		1.5 degree off-axis	
		Time *(minutes)*	Source	Time *(minutes)*	Source
Landsat-7	114.9	0.0	--	0.0	--
SAC-C	115.2	0.0	--	0.0	--
Note: Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total					

Hiroshima Manifest Analysis

Contention and Self-Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due To Contention *(minutes)*	Time Reduction Due To Self-Interference [5 degree off-axis] *(minutes)*
AQUA	122.3	23.6	0.0
EROS-A1	75.5	37.2	0.6 *[source: Landsat-7]*
Landsat-7	107.7	65.8	0.6 *[source: EROS-A1]*
SPOT-1	146.9	34.0	0.0

Note: Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total

[continued]

Hiroshima Manifest Analysis

Contention and Self-Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due To Contention *(minutes)*	Time Reduction Due To Self-Interference [5 degree off-axis] *(minutes)*
SPOT-2	147.3	28.8	0.0
SPOT-4	132.8	36.9	0.0
SPOT-5	135.1	40.1	2.2 *[source: Terra]*
Terra	117.0	49.8	2.2 *[source: SPOT-5]*
Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total			

Hiroshima Manifest Analysis

External Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due to External Interference			
		5.0 degree off-axis		1.5 degree off-axis	
		Time *(minutes)*	Interference Source(s)	Time *(minutes)*	Interference Source(s)
AQUA	122.3	0.0	--	0.0	--
EROS-A1	75.5	0.0	--	0.0	--
Landsat-7	107.7	0.0	--	0.0	--
SPOT-1	146.9	0.0	--	0.0	--
Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total					

[continued]

Hiroshima Manifest Analysis

External Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due to External Interference			
		5.0 degree off-axis		1.5 degree off-axis	
		Time *(minutes)*	Interference Source(s)	Time *(minutes)*	Interference Source(s)
SPOT-2	147.3	6.4 0.9 4.2 1.1	(1a,b) (2) (3) (4)	4.2 0.1	(5) (6)
SPOT-4	132.8	0.0	--	0.0	--
SPOT-5	135.1	0.0	--	0.0	--

Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total

Interference sources: (1) Adeos-II to Taejon_Kaist, Taejon_Kari; (2) Adeos-II to Hatoyama; (3) IRS-1D to Hatoyama; (4) Meteor-3M-N1 to Khabarovsk

[continued]

Hiroshima Manifest Analysis

External Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due to External Interference			
		5.0 degree off-axis		1.5 degree off-axis	
		Time *(minutes)*	Interference Source(s)	Time *(minutes)*	Interference Source(s)
Terra	117.0	3.1	(1)		
		3.1	(2)		
		2.2	(3)	1.0	(8)
		6.6	(4)	0.7	(9)
		1.7	(5)	0.7	(10)
		7.0	(6)		
		5.4	(7)		

Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total

Interference sources: (1) IRS-1D to Kumamoto; (2) IRS-1D to Hatoyama; (3) ERS-2 to Parepare; (4) ERS-2 to Hatoyama; (5) ERS-2 to Ulaanbataar; (6) ERS-2 to Kumamoto; (7) ERS-2 to Chung-Li; (8) IRS-1D to Novosibirsk; (9) IRS-1D to Hatoyama; (10) IRS-1D to Kumamoto

Kiruna_Esrange Manifest Analysis

Contention and Self-Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due To Contention *(minutes)*	Time Reduction Due To Self-Interference [5 degree off-axis] *(minutes)*
Adeos-2	350.4	224.6	0.7 *[source: Landsat-7]*
Coriolis	358.4	228.1	0.8 *[source: IKONOS-2]* 0.9 *[source: Landsat-7]* 3.6 *[source: Resurs-01-03]* 3.2 *[source: SPOT-4]*
IKONOS-2	304.0	249.1	0.8 *[source: Coriolis]* 1.6 *[source: Landsat-7]* 1.1 *[source: Resurs-01-04]* 0.8 *[source: SPOT-1]* 1.2 *[source: SPOT-2]* 8.0 *[source: SPOT-4]* 4.2 *[source: SPOT-5]*
Note: Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total			

[continued]

Kiruna_Esrange Manifest Analysis

Contention and Self-Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due To Contention *(minutes)*	Time Reduction Due To Self-Interference [5 degree off-axis] *(minutes)*
Landsat-7	313.7	237.2	0.7 *[source: Adeos-2]* 0.9 *[source: Coriolis]* 1.6 *[source: IKONOS-2]* 0.5 *[source: SPOT-1]* 3.6 *[source: SPOT-2]*
Resurs-01-03	296.3	138.7	3.6 *[source: Coriolis]* 0.6 *[source: Resurs-01-04]* 0.4 *[source: SPOT-4]*
Resurs-01-04	349.1	119.8	1.1 *[source: IKONOS-2]* 0.6 *[source: Resurs-01-03]*
Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total			

[continued]

Kiruna_Esrange Manifest Analysis

Contention and Self-Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due To Contention *(minutes)*	Time Reduction Due To Self-Interference [5 degree off-axis] *(minutes)*
SPOT-1	345.0	80.6	0.8 *[source: IKONOS-2]* 0.5 *[source: Landsat-7]*
SPOT-2	359.9	215.3	1.0 *[source: Adeos-2]* 1.1 *[source: IKONOS-2]* 3.6 *[source: Landsat-7]*
SPOT-4	363.8	242.8	3.2 *[source: Coriolis]* 8.0 *[source: IKONOS-2]* 0.4 *[source: Resurs-01-03]*
SPOT-5	346.8	55.4	4.2 *[source: IKONOS-2]*

Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total

Kiruna_Esrange Manifest Analysis

External Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due to External Interference			
		2.5 degree off-axis		1.5 degree off-axis	
		Time *(minutes)*	Interference Source(s)	Time *(minutes)*	Interference Source(s)
Adeos-2	350.4	0.1	(1), (2)	0.0	--
Coriolis	358.4	0.0	--	0.0	--
IKONOS-2	304.0	1.7 1.5 1.4 0.1 0.5 1.9	(3) (4) (5) (6) (7), (8) (9)	1.2 0.2 0.1 0.3 0.8	(3) (4) (5), (11) (7), (8) (9)

Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total

Interference sources: (1) AQUA to SGS_11.3m; (2) AQUA to Tromso; (3) Envisat-1 to Kiruna; (4) EO-1 to SGS_11.3m; (5) ERS-2 to Tromso; (6) ERS-2 to West-Freugh; (7) IceSat to SGS_11.3m; (8) IceSat to SKS; (9) IRS-1D to Neustrelitz; (10) ERS-2 to Neustrelitz; (11) ERS-2 to Kiruna; (12) Radarsat-1 to Tromso; (13) Radarsat-1 to Verkhoyansk; (14) Terra to Novosibirsk; (15) Terra to SGS_11.3m; (16) IRS-1B to Neustrelitz; (17) EROS-A1 to Sturup

[continued]

Kiruna_Esrange Manifest Analysis

External Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due to External Interference			
		2.5 degree off-axis		1.5 degree off-axis	
		Time *(minutes)*	Interference Source(s)	Time *(minutes)*	Interference Source(s)
Landsat-7	313.7	6.2 1.7 3.1 2.3 0.5 4.9	(3) (10) (5), (11) (6) (7), (8) (9)	4.3 0.3 1.7	(3) (7), (8) (9)

Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total

Interference sources: (1) AQUA to SGS_11.3m; (2) AQUA to Tromso; (3) Envisat-1 to Kiruna; (4) EO-1 to SGS_11.3m; (5) ERS-2 to Tromso; (6) ERS-2 to West-Freugh; (7) IceSat to SGS_11.3m; (8) IceSat to SKS; (9) IRS-1D to Neustrelitz; (10) ERS-2 to Neustrelitz; (11) ERS-2 to Kiruna; (12) Radarsat-1 to Tromso; (13) Radarsat-1 to Verkhoyansk; (14) Terra to Novosibirsk; (15) Terra to SGS_11.3m; (16) IRS-1B to Neustrelitz; (17) EROS-A1 to Sturup

[continued]

Kiruna_Esrange Manifest Analysis

External Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due to External Interference			
		2.5 degree off-axis		1.5 degree off-axis	
		Time *(minutes)*	Interference Source(s)	Time *(minutes)*	Interference Source(s)
Resurs-01-03	296.3	2.8 0.3 1.5	(9) (12), (13) (4)	0.4	(9)
Resurs-01-04	349.1	1.7 9.4 2.4 0.5 4.9 0.5 0.3	(10) (5), (11) (6) (7), (8) (9) (14) (15)	0.2 0.1 0.3 1.7	(4) (5), (11) (7), (8) (9)

Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total

Interference sources: (1) AQUA to SGS_11.3m; (2) AQUA to Tromso; (3) Envisat-1 to Kiruna; (4) EO-1 to SGS_11.3m; (5) ERS-2 to Tromso; (6) ERS-2 to West-Freugh; (7) IceSat to SGS_11.3m; (8) IceSat to SKS; (9) IRS-1D to Neustrelitz; (10) ERS-2 to Neustrelitz; (11) ERS-2 to Kiruna; (12) Radarsat-1 to Tromso; (13) Radarsat-1 to Verkhoyansk; (14) Terra to Novosibirsk; (15) Terra to SGS_11.3m; (16) IRS-1B to Neustrelitz; (17) EROS-A1 to Sturup

[continued]

Kiruna_Esrange Manifest Analysis

External Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due to External Interference			
		2.5 degree off-axis		1.5 degree off-axis	
		Time *(minutes)*	Interference Source(s)	Time *(minutes)*	Interference Source(s)
SPOT-1	345.0	1.4 5.8 2.6 5.6 0.2 3.6 0.4 0.6	(10) (5) (6) (11) (16) (9) (12) (15)	0.5 0.2	(5), (11) (12)

Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total

Interference sources: (1) AQUA to SGS_11.3m; (2) AQUA to Tromso; (3) Envisat-1 to Kiruna; (4) EO-1 to SGS_11.3m; (5) ERS-2 to Tromso; (6) ERS-2 to West-Freugh; (7) IceSat to SGS_11.3m; (8) IceSat to SKS; (9) IRS-1D to Neustrelitz; (10) ERS-2 to Neustrelitz; (11) ERS-2 to Kiruna; (12) Radarsat-1 to Tromso; (13) Radarsat-1 to Verkhoyansk; (14) Terra to Novosibirsk; (15) Terra to SGS_11.3m; (16) IRS-1B to Neustrelitz; (17) EROS-A1 to Sturup

[continued]

Kiruna_Esrange Manifest Analysis

External Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due to External Interference			
		2.5 degree off-axis		1.5 degree off-axis	
		Time *(minutes)*	Interference Source(s)	Time *(minutes)*	Interference Source(s)
SPOT-2	359.9	0.9 4.4	(17) (9)	0.5 0.4	(17) (9)
SPOT-4	363.8	3.6	(15)	0.0	--
SPOT-5	346.8	0.0	--	0.0	--

Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total

Interference sources: (1) AQUA to SGS_11.3m; (2) AQUA to Tromso; (3) Envisat-1 to Kiruna; (4) EO-1 to SGS_11.3m; (5) ERS-2 to Tromso; (6) ERS-2 to West-Freugh; (7) IceSat to SGS_11.3m; (8) IceSat to SKS; (9) IRS-1D to Neustrelitz; (10) ERS-2 to Neustrelitz; (11) ERS-2 to Kiruna; (12) Radarsat-1 to Tromso; (13) Radarsat-1 to Verkhoyansk; (14) Terra to Novosibirsk; (15) Terra to SGS_11.3m; (16) IRS-1B to Neustrelitz; (17) EROS-A1 to Sturup

PASS Manifest Analysis

Contention and Self-Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due To Contention *(minutes)*	Time Reduction Due To Self-Interference [5 degree off-axis] *(minutes)*
Envisat-1	300.4	198.2	0.7 *[source: EROS-A1]* 3.9 *[source: SPOT-2]*
EROS-A1	174.8	127.0	0.7 *[source: Envisat-1]* 3.6 *[source: SPOT-4]*
ERS-2	300.4	165.2	15.2 *[source: SPOT-1]*
Landsat-7	265.6	197.0	2.6 *[source: SPOT-4]*

Note: Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total

[continued]

PASS Manifest Analysis

Contention and Self-Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due To Contention *(minutes)*	Time Reduction Due To Self-Interference [5 degree off-axis] *(minutes)*
Radarsat-1	301.0	92.1	1.4 *[source: SPOT-5]*
SPOT-1	324.1	155.7	15.2 *[source: ERS-2]*
SPOT-2	323.2	179.9	3.9 *[source: Envisat-1]*
SPOT-4	317.1	91.8	3.6 *[source: EROS-A1]* 2.6 *[source: Landsat-7]*
SPOT-5	322.3	74.8	1.4 *[source: Radarsat-1]*

Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total

PASS Manifest Analysis

External Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due to External Interference			
		2.5 degree off-axis		1.5 degree off-axis	
		Time *(minutes)*	Interference Source(s)	Time *(minutes)*	Interference Source(s)
Envisat-1	300.4	1.0	(1), (2)	0.0	--
EROS-A1	174.8	0.6 1.2	(1), (2) (3)	0.1	(3)
ERS-2	300.4	0.7 44.5	(4) (3)	25.8	(3)

Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total
Interference sources: (1) EO-1 to PFTS_11.3m, (2) EO-1 to SGS_11.3m, (3) IRS-1D to Fairbanks-Space_Imaging; (4) IRS-1C to Fairbanks-Space_Imaging; (5) Adeos-2 to ASF_11.3m; (6) IKONOS-2 to Fairbanks-Space_Imaging; (7) Coriolis to North_Pole; (8) IRS-1B to Fairbanks-Space_Imaging

[continued]

PASS Manifest Analysis

External Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due to External Interference			
		2.5 degree off-axis		1.5 degree off-axis	
		Time *(minutes)*	Interference Source(s)	Time *(minutes)*	Interference Source(s)
Landsat-7	265.6	8.1 1.0 1.1	(5) (6) (3)	4.9 0.4	(5) (3)
Radarsat-1	301.0	0.0	(3)	0.0	--
SPOT-1	324.1	0.7 29.1	(4) (3)	19.4	(3)

Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total
Interference sources: (1) EO-1 to PFTS_11.3m, (2) EO-1 to SGS_11.3m, (3) IRS-1D to Fairbanks-Space_Imaging; (4) IRS-1C to Fairbanks-Space_Imaging; (5) Adeos-2 to ASF_11.3m; (6) IKONOS-2 to Fairbanks-Space_Imaging; (7) Coriolis to North_Pole; (8) IRS-1B to Fairbanks-Space_Imaging

[continued]

PASS Manifest Analysis

External Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due to External Interference			
		2.5 degree off-axis		1.5 degree off-axis	
		Time *(minutes)*	Interference Source(s)	Time *(minutes)*	Interference Source(s)
SPOT-2	323.2	8.1 1.0	(5) (6)	4.9	(5)
SPOT-4	317.1	1.7 1.0 3.3 1.5	(7) (1), (2) (6) (1), (2)	0.9	(7)
SPOT-5	322.3	0.6	(1), (2)	0.0	--

Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total
Interference sources: (1) EO-1 to PFTS_11.3m; (2) EO-1 to SGS_11.3m; (3) IRS-1D to Fairbanks-Space_Imaging; (4) IRS-1C to Fairbanks-Space_Imaging; (5) Adeos-2 to ASF_11.3m; (6) IKONOS-2 to Fairbanks-Space_Imaging; (7) Coriolis to North_Pole; (8) IRS-1B to Fairbanks-Space_Imaging

SGS_11.3m Manifest Analysis

Contention and Self-Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due To Contention *(minutes)*	Time Reduction Due To Self-Interference [5 degree off-axis] *(minutes)*
AQUA	558.7	66.2	0.0
EO-1	558.9	523.3	49.2 *[source: Landsat-7]*
IceSat	538.2	196.2	0.3 *[source: Landsat-7]* 1.3 *[source: Terra]*
Landsat-7	557.9	518.8	49.2 *[source: EO-1]* 0.3 *[source: IceSat]*
Terra	559.0	41.3	1.3 *[source: IceSat]*

Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total

SGS_11.3m Manifest Analysis

External Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due to External Interference			
		2.5 degree off-axis		1.5 degree off-axis	
		Time *(minutes)*	Interference Source(s)	Time *(minutes)*	Interference Source(s)
AQUA	558.7	0.1 0.4 0.2	(1) (2) (3)	0.2 0.1	(2) (3)
EO-1	558.9	2.0 2.2 2.2 3.1 1.3 2.9	(2) (4) (5) (6) (7) (8)	2.0 1.1 2.1 1.3 1.1	(2) (4) (6) (5) (8)

Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total

Interference sources: (1) Adeos-2 to Kiruna_Esrange; (2) Envisat-1 to PASS; (3) Meteor-3M-N1 to Obninsk; (4) Envisat-1 to Kiruna; (5) IKONOS-2 to Tromso; (6) IKONOS-2 to Fairbanks-Space_Imaging; (7) SPOT-2 to Obninsk; (8) SPOT-2 to Kiruna_Esrange

[continued]

SGS_11.3m Manifest Analysis

External Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due to External Interference			
		2.5 degree off-axis		1.5 degree off-axis	
		Time *(minutes)*	Interference Source(s)	Time *(minutes)*	Interference Source(s)
IceSat	538.2	0.1 0.3 0.9	(1) (2), (3) (4)	0.2	(2), (3)
Landsat-7	557.9	2.0 2.3 0.0 2.2 3.1 1.3 2.9	(5) (1) (6) (7) (8) (9) (10)	2.0 1.3 2.1 1.1	(5) (7) (8) (10)

Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total

Interference sources: (1) Envisat-1 to Kiruna; (2) ERS-2 to Tromso; (3) ERS-2 to Kiruna; (4) SPOT-4 to Kiruna_Esrange; (5) Envisat-1 to PASS; (6) Envisat-1 to Matera; (7) IKONOS-2 to Tromso; (8) IKONOS-2 to Fairbanks-Space_Imaging; (9) SPOT-2 to Obninsk; (10) SPOT-2 to Kiruna_Esrange

[continued]

SGS_11.3m Manifest Analysis

External Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due to External Interference			
		2.5 degree off-axis		1.5 degree off-axis	
		Time *(minutes)*	Interference Source(s)	Time *(minutes)*	Interference Source(s)
Terra	559.0	1.9 1.2 0.2 0.3 0.7 4.6 2.4	(1) (2) (3) (4) (5) (6) (7), (8), (9), (10)	0.3 0.3 1.6 0.8 0.5 0.0	(2) (4) (7), (8), (9), (10) (11), (12) (13) (14)

Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total

Interference sources: (1) ERS-2 to Tromso; (2) ERS-2 to Ulaanbataar; (3) ERS-2 to Kiruna; (4) ERS-2 to Miyun; (5) IRS-1B to Neustrelitz; (6) IRS-1D to Neustrelitz; (7) Resurs-01-04 to Novosibirsk; (8) Resurs-01-04 to Obninsk; (9) Resurs-01-04 to Sturup; (10) Resurs-01-04 to Kiruna-Esrange; (11) SPOT-2 to Kiruna_Esrange; (12) SPOT-2 to Aussaguel; (13) SPOT-2 to Maspalomas; (14) SPOT-2 to Fucino

[continued]

SGS_11.3m Manifest Analysis

External Interference *note: w/o frequency offset*

Spacecraft	Total Available Tracking Time *(minutes)*	Time Reduction Due to External Interference			
		2.5 degree off-axis		1.5 degree off-axis	
		Time *(minutes)*	Interference Source(s)	Time *(minutes)*	Interference Source(s)
Terra *[continued]*	559.0	3.3 0.5 2.4 0.0 1.2 1.0 1.8 1.9 1.4	(1) (2) (3) (4) (5), (6), (7), (8), (9), (10) (11) (12) (13) (14)	*see prior chart*	*see prior chart*

Three (3) day simulation period, noon March 1 – 4, 2003, includes 4320 minutes total

Interference sources: (1) SPOT-1 to Kiruna_Esrange; (2) SPOT-1 to Maspalomas; (3) SPOT-1 to Aussaguel; (4) SPOT-1 to Fucino; (5) SPOT-2 to Obninsk; (6) SPOT-2 to Kiruna-Esrange; (7) SPOT-2 to Aussaguel; (8) SPOT-2 to Fucino; (9) SPOT-2 to Obninsk; (10) SPOT-2 to Kiruna_Esrange; (11) SPOT-2 to Maspalomas; (12) SPOT-4 to Kiruna_Esrange; (13) SPOT-5 to Kiruna_Esrange; (14) SPOT-5 to Aussaguel